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Cabrera Salcedo

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With this thoroughly researched, carefully argued history of technology of nineteenth century Puerto Rico, Lizette Cabrera Salcedo has mostly succeeded in challenging the notion that the Caribbean island was technologically and scientifically stagnant until the U.S. occupation in 1898. In the century-and-a-half preceding that fateful date, the author demonstrates, a small but dynamic group of Puerto Rican scientists, surveyors, engineers, and planter-inventors collaborated with a mostly supportive Iberian metropole to modernize the production of sugar—by far the island’s most important export commodity. Requiring irrigation projects, hydrological and geological surveys, soil analysis, and broad engineering acumen, as well as the more familiar struggles of modernizing activities in the sugar mill itself, Puerto Rico’s “creole model of economic development” put the island squarely in the currents of the Industrial Revolution, broadly construed.

The framing of the book is interesting: Cabrera uses the multi-century history of a particular human invention (the three-cylinder mill used to squeeze sweet juice out of raw sugarcane) as a useful trope through which to explain Puerto Rican economic and social history. Changes in the relationship between colony and metropole, slavery and capitalism, island and mainland are related to the contraption’s ongoing redesign both in terms of its shape and size and in terms of the materials used to construct it. Most important to Cabrera are changes over time in terms of the motive force that was used to turn the cylinders: from oxen to steam engines, as the book’s title implies (with a minor but important parenthesis for waterpower). In its use of an object (at once commodity and machine) as metaphor for colonial and postcolonial history, *De los bueyes al vapor* reminds of the memorable narrative strategy used in Fernando Ortiz’s classic *Contrapunteo cubano* (2002).

The question of who invented, or improved, this all-important mechanism, as well as other sugar-related technologies, occupies much of the author’s attention. In the early chapters, which offer a fascinating global tour of sugar manufacture since ancient times, Cabrera corrects

scholars who have missed the major contribution of Luso- and Hispanic-American predecessors to the British, Dutch and French Caribbean sugar islands in the seventeenth-century. She thus compellingly recasts the European “wars beyond the line” as conflicts over sugar: those who lacked it (or the wherewithal to produce it) attacked those who had it. She also offers a tantalizing footnote about the hitherto unexplored role of inter-imperial contraband trade in early modern technology transfer in the Caribbean (p. 79, note 57).

When she moves to the eighteenth century, Cabrera continues to give the reader a rich, pan-Caribbean picture of sugar technology, expanding geographically on the important recent work of Mercedes García (2007), which similarly seeks to challenge the notion that there wasn’t much going on in the Spanish-American sugar industry until after 1790. If the takeoff of French, English and Dutch sugar exports in the early seventeenth-century was indebted to the know-how of Spanish colonials, the roles were reversed in the mid-eighteenth century. The Spanish government’s willingness to allow the immigration of foreign experts, as well as the duty-free importation of foreign hardware, would turn out to have important effects. Cabrera brings to life the business-minded scientists who capitalized on the Bourbonist support of freer trade, as well as the educational, cultural, scientific Atlantic worlds of which they were part. Juan Ramos, a native of Puerto Rico who traveled widely in support of his sugar-related inventions, or the ecologically-prescient geographer Francisco Valls are fascinating characters who have received too little attention in a Caribbean historiography overwhelmingly preoccupied with masters and slaves.

The “who invented it?” conundrum, long the overriding concern of traditional historians of technology such as Lynn White, is turned in this book to nationalist ends, used to exhume an indigenous history of technical ingenuity and insight. Cabrera’s defense of Puerto Rican inventiveness takes on a strident nationalist tone in the footnotes, which will be strong medicine for some readers. Of Richard Dunn’s hypothesis that seventeenth-century English sugar planters learned little from Hispanic settlers, Cabrera says, “Suffice it to say that prejudice and lack of knowledge should not be the criteria for the formation of the best historical notions and conclusions” (p. 77, note 37). For the record, she is hardly more forgiving of Puerto Rican scholars. She dismisses one of Juana Gil-Bermejo’s claims as “a simplistic formulation, reflecting a lack of exhaustive research” (p. 92, note 4). Of more concern to this reviewer is that Cabrera’s search for hometown heroes (an important task, especially in the context of a historiography that has consistently accused the Puerto Rican sugar industry of backwardness) can sometimes oversimplify the complicated transnational histories of many of the innovations

the author wants to call either Puerto Rican or foreign. For example, the “vacuum pan” method credited to Paris-based manufacturer Derosne and Cail was actually the outcome of collaboration among European engineers and planters and plantation managers in Cuba, Puerto Rico, Martinique and elsewhere, who together conducted trial runs of early versions of the machine, suggesting improvements based on the ordeal of an actual sugar harvest. Without these colonial colleagues, Derosne (who spent time working in all these places) would have had much more trouble adapting the machine to the strict timelines and sensitive chemistry of sugar-making in the colonies.

More focused than Manuel Moreno Fraginals’s capacious *histoire totale* of the Cuban sugar economy, *De los bueyes al vapor* is a history of technology that leaves the reader to make connections between the logistics and the hardware of sugar production and what Moreno would call “the socio-economic complex” that arose around it (Moreno 1978). As Cabrera acknowledges in her introduction, macro-economic and micro-economic dimensions of the Puerto Rican sugar industry will have to wait for a future volume. While this reviewer would have appreciated a more cohesive socio-economic context within which to understand Cabrera’s masterful analyses of sugar science, the book already weighs in at 500 pages and has given us much to discuss.

Cabrera fills a major gap in the historiography of slavery in the Americas, a literature which has premised much on a supposed technological backwardness without serious investigation of the technologies, or the knowledges, being developed in slave societies. Especially in her sustained analysis of water-control infrastructure for the purpose both of driving machinery and irrigating cane fields (especially in the dry south half of the island), as well as in her insistence that minor, incremental, experience-based improvements to existing machinery could have very important efficiency improvements, Cabrera opens up new terrain that should occupy more scholarly attention than it has. When we unpack and take a close look at the machines themselves, the author proves, we discover much that surprises us about the societies who made them and used them.

Like other good histories of technology, this book insists that complicated logistical and financial problems attended any change in technology. Her example of the choice planters made between a mill powered by animal, water, or steam, is exemplary. While the water flowing downhill from the island’s central cordillera was in a sense a free source of power, to actually harness it required major earth-moving projects, the building of dams, races, and of course precise calculations of the volume of water needed both per second and over a year in order to run the mill. These projects called forth expertise in the latest hydrological methods for

measuring water flow, as well as some creative financing by the richest planters of the island. Designing, purchasing, manufacturing, and maintaining a large water wheel, complicated in its own right, was only the beginning. The wheel also had to be supplied with water, and harnessed efficiently to the mill, all of which proved challenging.

A steam engine, meanwhile, in theory a wonder machine able to solve all problems, brought complications of its own. First of all, the use of steam engines was predicated upon nearby fuel sources to heat the boilers, as well as a dependable supply of replacement parts, and a critical mass of artisan know-how to keep the engines running. Furthermore, the adoption of the steam engine transformed but did not reduce the need for human muscle. Grinding cane much faster than the ox-driven sugar mills of yore, more slaves were needed to undertake the arduous task of cutting cane in the fields. In turn, more oxen were needed to bring the carts full of sugar cane to the mill. These oxen had to eat, so land that might have been used to grow cane had to be dedicated to growing feed crops. The author does an admirable job of explaining how such ancillary factors, often overlooked, shaped the investment decisions of planters and the government.

At important moments, however, Cabrera retreats from the nitty-gritty history of technology. When it comes time to explain how a particular technology functioned she sometimes quotes long blocks of text from her primary sources, as opposed to explaining these machines in simple terms to the reader (see especially pp. 402-404). There are also particularities of steam engine and waterwheel design that Cabrera ignores, at some peril to her own arguments. Most of the steam engines used on Puerto Rican plantations appear to be (I am judging from the images Cabrera includes) low-pressure, single upright cylinder, stationary engines of the "grasshopper" type. One of the oldest steam engine designs around, many machinists throughout the Atlantic world thought of this bulky contraption as backwards, inefficient, and mostly good for pumping water. By 1861, the date of Puerto Rico's most well-known steam engines was erected on the Hacienda la Esperanza, there were dozens of other designs available. Were these alternatives considered by the engineers who ended up buying the grasshopper engines? Did they stick with the older design for practical reasons? Were these cheaper than the latest models? What kind of benefits did this type of engine design bring to the specific task of grinding sugar cane? Closer attention to such questions would have opened up new vistas on nineteenth century technology history in the colonial world.

There was just as much ferment and debate in the world of water-power design. In spite of improvements to stationary steam engines, water provided the majority of motive power to U.S. industry until very

late in the nineteenth-century. There were several major waterwheel designs, as well as the water-turbine, to choose from. While Cabrera discusses the importance of Puerto Rican planters harnessing the power of water for the sugar industry, she does not tell us what kind of wheels were used. An 1876 drawing of the waterwheel to be used on the Hacienda Adela by Cipriano Blondet clearly shows an overshot breast wheel. While large breast wheels were still very much in use, the overshot design had fallen out of favor since the bottom of the wheel rotated against the current of the waterway. If the water was low, this was not a problem. But if rains raised the water level to submerge part of the wheel, the wheel would be fighting the current, and hence sacrifice much of its power in doing so. This is why the vast majority of large, industrial breastwheels were of the undershot variety by 1876. Why was this not an issue on the Hacienda Adela? And more importantly, would entertaining these detailed technological questions about steam engine and waterwheel design create problems for the book's central argument about the modernity of science and technology in nineteenth century Puerto Rico?¹

My only other complaint is that there is next to nothing in this lengthy book on slavery, anti-slavery, the slave trade, or the fascinating question of the role that particular enslaved workers played in the development or the incorporation of new technologies. Which means that labor history (how workers experienced ongoing technological change, what it meant for them, and most simply, how some of these contraptions actually worked in practice), is consigned to the edges of the frame.²

One can only hope that some of the questions raised in this admiring reader's review will be answered in the eagerly awaited second volume.

Notes

¹ For clear explications of these at-first-glance puzzling questions of machine design, see Louis Hunter, *A History of Industrial Power in the United States, 1780-1930*, 3 vols., (Charlottesville, University Press of Virginia, 1979-1991).

² See Philip Scranton, "None-too-Porous Boundaries: Labor History and the History of Technology," *Technology and Culture* 29, vol. 4 (1988), pp. 722-743.

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¡Fiebre amarilla y malaria! La obesidad, el síndrome metabólico, la diabetes y la arteriosclerosis son enfermedades que se asocian cada vez más al azúcar. Estas asociaciones, si bien importantes, ya han dejado de ser noticia, al ser mencionadas con frecuencia en las revistas de divulgación médica. Ahora bien, relacionar el azúcar a la malaria y la fiebre amarilla y a sus vectores, los mosquitos, ¡eso es una noticia! Con mayor precisión, asociarlos a la caña de azúcar y a las plantaciones azucareras en la cuenca e islas del Caribe es una novedad. Más aun, se postula que el efecto de estos mosquitos y las enfermedades transmitidas por ellos fue decisivo en las pugnas imperiales y revolucionarias de la época colonial caribeña entre el 1620 y el 1914 hasta ganarles el título a estas potencias de ser “imperios de mosquitos”. Esta es la imaginativa tesis de John Robert McNeill, autor de esta obra.

McNeill es un conocido historiador ambiental, investigador y catedrático de la Universidad de Georgetown, en el Departamento de Historia y la Walsh School of Foreign Service. Su obra trata sobre historia ambiental del Caribe, la historia de la enfermedad, la historia de las revoluciones americanas y de la lucha de los imperios europeos por el control de las riquezas de América en el Gran Caribe, desde Chesapeake hasta el Noreste de Brasil, entre 1620 al 1914.

McNeill, quien al igual que su padre —el igualmente distinguido historiador William McNeill—, ha sido premiado con el premio Toynbee por sus “contribuciones académicas y públicas a la humanidad”, ha llevado a cabo esta considerable labor con una pericia y profundidad

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